COSC 6377

Computer Networks

Fall 2023 - Exam 1

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1. This is an open book open notes exam.

2. We will also provide a computer you can use to access the Internet during the exam. You are also welcome to use your computer but without Internet.

3. If you write down "No idea" as an answer to a sub-question, you will receive 2 for that sub-question. An incorrect answer is worth 0 point.

4. There are 4 questions in this exam.

5. I certify that I have abided by the UH Academic honesty policy while taking this exam.

Signature: Ashutosh Kumar

Page	Questions	Score
2	1ab	25 /25
3	2ab	15/25
4	3ab	21.5/25
5	4ab	20 /25
Total		81.5/100

Question 1: RTT estimation and Retransmission (25 points)

Harry's implementation of a STOP-N-WAIT protocol (window=2) uses estimated RTT to set the timer for packet retransmission: if an ACK is not received within the timer value, the packet is retransmitted. EWMA is used to estimate RTT with an alpha of 0.8 every time A receives an ACK. Node A is the sender and node B is the receiver. Here is a trace of activities at node A which indicates a permanent increase in RTT after certain time.

Time	Activity
1	SEND SEQ=1
2	SEND SEQ=2
3	RCV ACK SEQ=1
4	RCV ACK SEQ=2
5	SEND SEQ=3
6	SEND SEQ=4
10	RCV ACK SEQ=3
11	RCV ACK SEQ=4

Let
RTT0 = 1

1.a. At time step 12, what is the value of retransmission timer if A were to send a packet with SEQ=5? Show your work. [15 points.]

At Time 3: $(0.8 \times 2) + (0.2 \times 1) = 1.8$

At Time 4: $(0.8 \times 2) + (0.2 \times 1.8) = 1.96$

At Time 10: $(0.8 \times 5) + (0.2 \times 1.96) = 4.392$

At Time 11: $(0.8 \times 5) + (0.2 \times 4.392) = 4.8784$

15

∴ Retransmission Timer at $T12 = 4.8784$

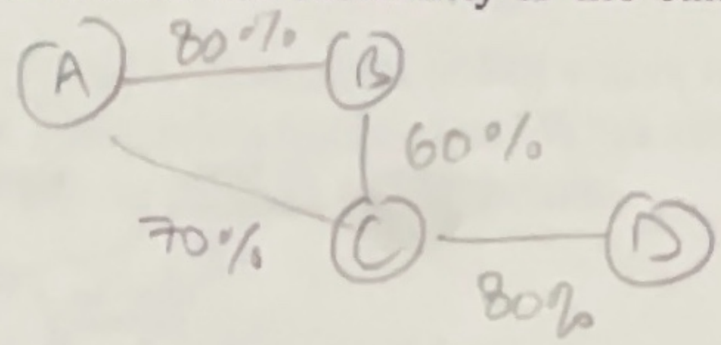
1.b. How many ACKs might you miss with the retransmission timer (and end up performing spurious retransmission) above if the RTT is not updated after time step 12 due to a bug but the sender continues to send the packets? Show your work. [10 points.]

If the timer is not updated, we will miss every ACK that take 4.8784 units of time to be received after the sender has sent the packet.

10

Question 2: Routing and Link Metrics (25 points)

2. We have a network consisting of four nodes in this topology with these bi-directional link reliability [bi-directional means the reliability is the same in both directions]:



0.8 x 0.6 x 0.8 = 0.384
0.7 x 0.8 = 0.56

A-B [link reliability – 80%]
B-C [link reliability – 60%]
A-C [link reliability – 70%]
C-D [link reliability – 80%]

2.a. Can we use the standard shortest path algorithm we studied with this metric? If the answer is not, please describe the precise change you have to make to the metric or the algorithm. If the answer is yes, please describe no change is needed to the metric or the algorithm. [10 points.]

Yes, no change is needed.

10

2.b. What is the best and 2nd best path between A and D and why? [15 points.]

Best path: A → C → D

↳ Efficiency = 0.7 × 0.8 = 0.56

or 56% efficiency

15

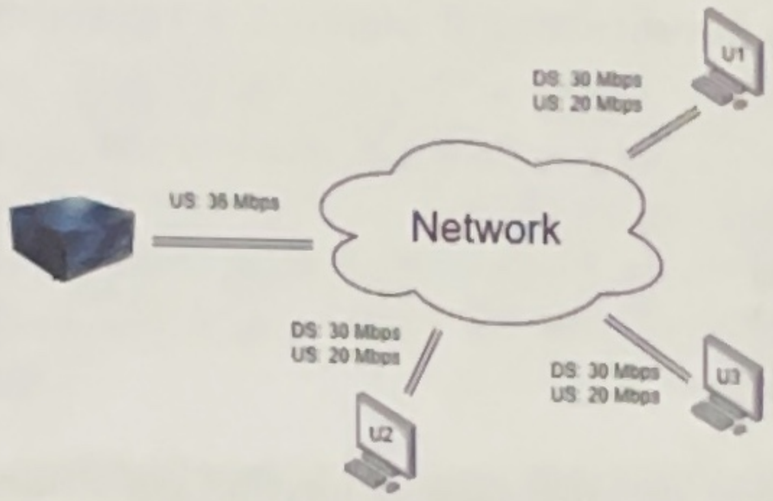
2nd best path: A → B → C → D

↳ Eff. = 0.8 × 0.6 × 0.8 = 0.384

or 38.4% eff.

A → C → D has the best efficiency, hence is the best.

Question 3: Peer-to-peer Network (25 points)



In the peer-to-peer network above, please design two ***architecturally different*** mechanisms appropriate for a real-world peer-to-peer that allows U1 to know if U2 has file-chunk that U1 is interested in downloading.

3.a. Design of mechanism 1. Please state the advantages and disadvantages of your design. [12.5 points.]

U_1 can directly ask U_2 for the data (or probe), and if U_2 has the data, it can send, otherwise, it can tell U_1 that U_2 doesn't have that data.

Advantage — Users can talk to each other, without congesting the link to the server.

Disadv. — the users need to know about each other, what happens when U_2 doesn't have data

(12.5)

3.b. Design of mechanism 2. Please state the advantages and disadvantages of your design. [12.5 points.]

U_1 can ask the server to whom it has sent the data. Then U_1 can approach those users.

Advantages - The users don't need to know about each other. The server can give that information, as the server knows everything / can keep track of everything.

Disadv. — The server will have to both, serve the data & handle user queries about where parts of the data are. Additional bookkeeping.

Question 4: Miscellaneous (25 points)

contd. on NEXT PAGE.

4.a If an application is ***only interested*** in reliable data transfer but wants to build on top of UDP, what mechanisms should the application implement? What are the advantages and disadvantages of that/those mechanisms? [15 points]

(13)

The application needs to add reliability and congestion control, because UDP doesn't guarantee these, while TCP does. E.g. HTTP/3 adds the above.

Reliability means that there is guarantee that our payload will definitely reach the destination. UDP doesn't guarantee this, so the application needs to implement this feature.. (This can be done by adding ACK messages etc.)

UDP simply sends the packet and doesn't know if they are being dropped due to congestion. The app. needs to add the feature to detect congestion and slowdown the rate at which msg. are being sent.

4.b If we have two devices that use different formula for backoff timers at the CSMA-CD MAC layer, can they send/receive messages between the two of them? Why or why not? [10 points.]

(7)

No. This is because, upon detecting a collision, both will backoff and send the data again simultaneously (if they detect at the same time), which will lead to another collision.

If they have different backoff timers, then one will send the message before the other, hence no collision.

4a) The advantage is that since UDP is light-weight, the application can customize what they need. There may be features that they need that TCP does not provide or perhaps some that TCP provides that they do not require.

The disadvantage is that applications need to take on more responsibility, which was previously the responsibility of another layer. This can increase the chances of error, as everyone has to implement these.